PROF. W. H. WALKER.

ORGANIC CHEMISTRY

Carbon Is the Most Important Element in This Study

By F. J. MOORE.

It is a matter of regret to every organic chemist that the subject of his chief interest should be so often regarded by the layman as something of great difficulty and complexity. This is perhaps due in part to the magnitude of the formulæ with which he is accustomed to fill his publications. Possibly, too, the fact that the study of Organic Chemistry is, for no very adequate reason, begun so late in most courses on Chemistry, leads the student to assume that it must offer special difficulties. The truth of the matter is rather the reverse of this apparently general impression.

Organic Chemistry is devoted to the study of a single element—carbon. On account of the regularities which govern the properties of the many compounds of this element, the subject has been most consistently and logically developed, and it is therefore characterized by a unity and consequent facility of apprehensions hardly attained in any other equally extensive department of science. For its forbidding formulæ, too, the organic chemist feels no wish to apologize, for even the beginner soon learns that these have a helpfulness and simplicity nearly proportional to their length.

It is probable that almost every one who begins the study of Chemistry originally expects to acquire therefrom information concerning the substances most frequently met with in the operations of daily life. Inorganic Chemistry, however, with which the student first enters upon the subject, soon offers him such a wealth of fascinating information concerning chlorine and phosphorus, fluorine and argon, and a hundred other substances of which he had never before heard, that he unconsciously loses his curiosity concerning the food which he eats, the clothes which he wears, the flesh which covers his bones, and the many articles like paper, wood or india-rubber with which he daily comes in contact. These all get classified in his mind under the miscellaneous heading, "organic matter"—a term even more heterogeneous in its significance than the much-abused "basic salt."

Now it is concerning things of the kind just mentioned that Organic Chemistry even now can give much information of wonderful accuracy and completeness. In some cases, of course, only a beginning has been made; but there is no doubt that, in the immediate future, there will be a rapid advance toward the solution of problems as complicated as those involved in the transformations going on in the living tissues. For this reason—that Organic Chemistry has so much to tell us concerning the details of daily life—it might well have a more conspicuous position in the curricula of our colleges than it has hitherto enjoyed. The mental training which the subject affords is also of no mean order, for few studies impart more successfully the power of reasoning by analogy.

For those who approach the study of Chemistry with the professional point of view, and in the desire to make their scientific training of use in the pursuit of a livelihood, it should be pointed out that a great number of industries have to do with the handling and transforming of organic substances and, in consequence, require for their development the services of men well trained in Organic Chemistry. These industries include the manufacture of drugs and colors, that of soap and candles, tanning, dyeing, and the textile industries, the manufacture of explosives, the refining of sugar and of oil, the distillation of spirits, the preparation and analysis of food products, and many more.

It should be conceded at once that several of the above, like tanning, soap-making, and the distillation of spirits, have, until comparatively recently, in this country, developed along empirical lines, and have been conducted, with a fair measure of success, by men trained very superficially if at all in Organic Chemistry or any other branch of the subject. These conditions are, however, rapidly passing away never to return. The necessity of conserving resources, of which we now hear so much, means an increasing scarcity of raw materials, and this, together with the increasing pressure of international competition, is forcing the manufacturers to introduce intensive methods of production, and these, in turn, are only possible under a regime controlled by scientific knowledge and trained ingenuity.

What can be accomplished by these agencies' is best illustrated by the familiar example of the coal-tar industry in Germany, where the strict application of scientific principles and technical knowledge transformed what was once the most useless and obnoxious of by-products into a veritable treasury of colors, remedies, and perfumes. This industry did not stop with the utilization of a by-product, but expanded in all directions until, in a sense, it changed the face of nature; for it modified the agricultural policy of vast areas when it substituted coal-tar alizarin for the extract from the madder-root, and drove a large portion of the natural indigo from the markets of the world, to place there the cheaper and purer product synthesized from napth alene.

Results like this were attained by combining the extraordinary foresight of the German manufacturer with the eminent research-ability of the university-trained scientist. As a consequence, theoretical scientific training has come to its full honor in German industrial life, and the laboratories of the great factories vie with those of the universities in the high quality of their scientific researches, while they surpass them in their equipment, and in the mechanical facilities for investigation which they afford.

That similar t_ansformations are soon to be brought about in the industries of this country no one can doubt. Research Laboratories are already springing up in connection with the operations of many of our large industrial corporations, and the generation of young men who are just now taking their places in industrial life are bound to witness the most rapid developments yet realized along this line. It is the ambition of the Institute of Technology to so train her sons that they shall be leaders and worthy workers in this movement.

Our course in Organic Chemistry for Chemists and Chemical Engineers begins in the second term of the third year and continues for two terms. During this time, the student attends an extended course of lectures upon the principles of the science, and receives practice in laboratory work of a varied character. In the latter it is the special aim of the instructing force to keep closely in touch with the individual student, and to help him in the application of theory to practice, and in obtaining the widest possible scientific outlook from the immediate work he happens to have in hand; never allowing the latter to become a matter of mere routine manipulation. The work done in the identification of organic compounds gives valuable training in applying ingenuity to the solution of minor problems in Organic Chemistry. A larger opportunity in the same direction is, of course, afforded to those who elect theses in the subject, while ample facilities are placed at the disposal of those who desire to undertake extensive investigations after graduation.

OBJECT OF COURSE X

Chemical Engineering Making Rapid Advance

By KARL BURROUGHS,
Supt. Fort Hill Chemical Co.

The object of this course is clearly stated in the catalogue and graduates expect to engage in those branches of industrial manufacture which either depend upon or involve chemical principles. That is, in addition to those industries engaged solely in the production of chemicals, numerous others such as the manufacture of cement, soap, paper, glass, glue, gas, explosives and abrasives require a knowledge of chemistry at some part at least of the process.

Thus the field for employment offered by the course is chiefly that of industrial manufacture which in a general way is not so broad as that afforded by some of the older engineering courses. A mechanical engineer has the entire field of manufacture; a mining engineer has only mining enterprises to be sure but they seem liable to involve about everything from railroad construction to commercial manufacturing; an electrical engineer has some lines of manufacture and also the numerous public utilities. As compared with these branches, chemical engineering is much less developed and on the whole this is true of the industries to which it pertains, as far as this country is concerned. It will be found that there are comparatively few such engineers in consulting practice, which I think is due partly to the difficulty in acquiring the requisite practical information and to the fact that demand for such services is small. In fact, owing to varied conditions, and a common lack of knowledge, applicable to such industries, they are more prone to depend upon technical men who have been developed directly in their service. Hence the graduate usually begins work as an apprentice, or aids on some line of commercial research or perhaps in the laboratory or drafting room.

At the start some such work is necessary no matter what particular branch of the profession one ultimately desires to follow, i. e., commercial manufacture or consulting work. That is, some knowledge of practical affairs must be had and also opportunity for developing a sound judgment in such matters.

These industries are to some extent susceptible of division into two classes, viz., those which have developed on so broad a scale that they have but little in the way of secret processes and those which are the results of the development of inventions, where the practical details are either secret or but meagrely known.

The former class comprises those, where owing to demand for their products, manufacture has been extensively undertaken—cement, gas and paper for instance. Owing to the highly advanced stage such industries have reached, apprenticeship is the best route for a technical man to enter them if he desires to master the business. Take the manufacture of paper for example—the product is the result of an extended series of mechanical operations and a thorough grasp of its essentials is not to be acquired by cursory inspections or a casual knowledge of the principles involved.

The second class of industry will only offer a general apprenticeship in exceptional cases. Most technical men enter such industries either in the laboratory or some line of commercial research. The laboratory is the better place to begin, as it affords one some opportunity to observe the operations in actual practice. Experimental or research work as a starter usually means some labor lost before a full realization of practical details is acquired but the work is interesting, especially for those who have the ability to actually do things themselves.

The future of this field is difficult to predict beyond the fact that it is growing. Thus in the past decade it has seen great expansion along such lines as the manufacture of cement and electro-chemical products. The former has about spent its force, while the latter is still due for some further expansion. Growth may also be anticipated to a somewhat limited extent throughout all these industries as the demands become greater.

This course deals with a branch of engineering whose problems are extremely varied and largely undeveloped, hence I do not think it advisable to adopt the course with a view of attempting to specialize. The course is now well adapted for its purpose, viz., the laying of a foundation for acquiring and using a great breadth of scientific knowledge applicable chiefly to chemical problems of an industrial nature.

TECHNICAL ANALYSIS

Examination Of Substances Manufactured Every Day

By DR. A. H. GILL.

This covers an unfamiliar field. Most of us understand the meaning of the terms qualitative and quantitative analysis when applied either to the inorganic or organic world, but have no idea of the subject matter of this article. It deals with the manufacture and analysis of certain substances which are not included in the ordinary analytical chemical course: these are Asphalt, Celluloid, Glue, Inks, Paper, Soaps, Tanning Materials and Leather, Varnishes, Rubber, Boiler Water, Alkaloids. Strangely enough the mere analysis of these compounds is not the chief object sought.

The aim of the course is to encourage individual thinking and foster the spirit of research. While the mere analytical chemist is a necessity—as is the day laborer—yet he is not the highest type. Men with initiative are wanted much more than those with analytical skill; incidentally a knowledge of some new or additional analytical method is of course acquired.

The student is asked to imagine himself graduated and, for example, in a steel works laboratory, making the usual routine analyses; his superior brings him in a sample of rubber upon which he wishes a report as to its availability and value. The subject is read up in some general work as Thorp's "Outlines of Industrial Chemistry" and in the special treatises. The latest numbers of such periodicals as "Chemical abstracts" or the "Chemisches Zentralblatt," "J. Soc. Chem. Industry," etc. are consulted for articles bearing upon the subject in hand. Notes are to be taken upon what is read so that an intelligent talk or paper occupying fifteen or twenty minutes can be presented in the class room; this is expressed in accordance with the principles learned in the study of English, and should be concise but fairly comprehensive. This paper is to be handed in and is kept among the records of the laboratory. The other students are required to take notes upon these talks and the class room exercise is often preceded by a quiz upon the earlier papers. For the laboratory work careful working abstracts of the method to be pursued are made in the laboratory notebook; but before these methods are put in practice a consultation should be had with the instructor as to the best method of procedure. Particular stress is laid upon the keeping of the laboratory notebook as a very important adjunct of research work.

Oils and Gas Analysis.

Besides the work just detailed instruction is given in this same laboratory in the anlaysis of oil and gases. In the former course the usual tests are applied to the various oils to determine their safety and availability for the purposes for which they were intended and also for the identification of the oils. Courses in the analysis of fuel, illuminating and chimney gases, with a discussion of the application that these analyses have upon the economy of manufacturing operations, are given to the students in Courses V., X., XIV., II., VI., and XIII.